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ON THE

WEIGHT AND SPECIFIC GRAVITY OF THE BRAIN.

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IN 1847,[*] I published a series of weights of the human brain, collected at the Royal Infirmary of Edinburgh, together with tables prepared from these observations, as well as the much larger number of weights previously recorded by the late Professor John Reid.[†] The observations which follow have been obtained since that time, and though comparatively few in number, yet as they are not likely to be materially increased and may furnish an useful comparison with the former, I have thought them worthy of being placed on record.[‡] The observations on the specific gravity of the brain are entirely new. They were obtained by a different mode from that followed by Dr. Sankey,[§] in his observations of the specific gravity of healthy brain, and by Dr. Bucknill[||] in his investigation of the density of the brain of insane persons. The former of these observers ascertained the specific gravity of the different portions of the brain by placing pieces in solutions of common salt of different densities; the latter adopted a similar plan, but employed solutions of Epsom salts. My own observations were made by first weighing the brain and its several portions in air, and then in distilled water, and calculating the specific gravity by the common formula, viz., as the weight lost by the brain in water, is to the weight in air, so is the specific gravity of distilled water (1,000), to the weight required.

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[*] "Edinburgh Monthly Journal," Vol. VII. (N.S. Vol. I.) 1847. [†] *Ibid*, 1843.

[‡] Some of these have been previously published, but no calculations have been based upon them. "London Journal of Medicine," Vol. I., 1851.

[§] "Brit. and For. Med. Chir. Review, Vol. XI., 1853, p. 240.

[||] "Lancet," 1852, Vol. II. p. 588; and "Brit. and For. Med. Chir. Review," Vol. XV. p. 207.

TABLE I.

Weight of Healthy Brain, &c., and Cause of Death in Males and Females.

MALES.

No.	Age.	Weight of										Cause of Death, &c.
		Whole Body.		Encephalon.		Cerebrum.		Cerebellum.		Pons Varolii & Medulla Oblongata.		
		lbs.	oz.	oz.	dr.	oz.	dr.	oz.	dr.	oz.	dr.	
1	2	24	0	43	7	38	6	4	8	0	9	Burn; died in 21 days.
2	2	...		37	0	...		...		...		Malformation of heart.
3	2½	31	8	47	0	42	0	4	4	0	12	Burn; died in 6 hours.
4	3	25	4	38	1	33	3	4	2	0	12	Burn; 15 days.
5	4	...		50	10	45	8	4	8	0	10	Burn; 12 hours.
6	5	21	0	45	12	40	0	5	0	0	12	Cholera; 6 days; spinal cord 11 dr. 14 grains.
7	10	45	0	47	12	42	0	5	0	0	12	Cholera.
8	11	...		46	0	40	0	5	0	1	0	Fever.
9	14	...		48	12	43	0	5	0	0	12	Fever.
10	15	88	0	50	8	44	0	5	8	1	0	Instant death from injury.
11	15	...		41	10	36	0	5	0	0	10	Phthisis.
12	15	...		49	4	43	8	4	12	1	0	Malformation of heart.
13	16	...		43	8	38	0		5	8		Fever.
14	20	...		37	0	32	4	4	0	0	12	Malformation of heart.
15	21	119	0	51	0	...		...		...		Phthisis; fatal by hæmoptysis.
16	24	...		47	8	41	8	5	4	0	12	Fever.
17	24	97	0	46	1	40	4	4	12½	0	12½	Phthisis.
18	25	...		48	8	42	0	5	8	1	0	Fever.
19	21	121	0	51	0	45	0	5	0	1	0	Cholera.
20	29	...		52	0	46	0	5	0	1	0	Cholera and diseased heart.
21	29	...		49	3½	43	0¼	5	2½	1	1	Lumbar abscess.
22	30	...		59	8	53	0	5	8	1	0	Fever.
23	33	...		48	8	42	0	5	8	1	0	Pleuro-pneumonia.
24	32	...		48	0	...		...		...		Morbus cordis.
25	37	99	0	49	0	43	0	5	0	1	0	Fever and erysipelas.
26	40	106	0	47	0	...		...		...		Phthisis; fatal by hæmoptysis.
27	42	...		46	8	41	0	4	10	0	14	Chronic diarrhœa.
28	45	...		52	12	45	8	6	4	1	0	Phthisis.
29	48	...		50	6	43	10	5	10	1	2	Morbus hepatis, ascites.
30	51	...		45	0	39	8	4	8	1	0	Bronchitis and diseased heart.
31	50	...		56	4	50	0	5	8	0	12	Erysipelas and diseased heart.
32	55	84	0	45	15	39	11	5	5	0	15	Carcinoma of Pelvis.
33	60	...		51	0	45	0	5	0	1	0	Cholera.
34	65	...		47	6	41	4	5	6	0	12	Intus-susception and diseased heart.
35	70	...		42	4	37	0	4	8	0	12	Morbus cardis et hepatis.
36	78	...		48	0	42	0	5	0	1	0	Injury of head and diseased heart.

FEMALES.

No.	Age.	Weight of Whole Body.		Weight of Encephalon.		Weight of Cerebellum.		Weight of Cerebellum.		Weight of Pons Varolii & Medulla Oblongata.		Cause of Death, &c.
		lbs.	oz.	oz.	dr.	oz.	dr.	oz.	dr.	oz.	dr.	
1	7 days	7	0	14	1	12	13	1	$0\frac{1}{4}$	0	$3\frac{3}{4}$	Medulla spinalis, $2\frac{1}{2}$ drchs.
2	1 year	15	0	31	8	27	0	4	0	0	8	Phthisis.
3	3	22	0	39	10	34	8	4	8	0	10	Burn; 1 day.
4	3	22	0	34	10	30	8	3	11	0	7	Burn; 4 hours.
5	5	28	0	41	8	36	8	4	4	0	12	Cholera; 1 day.
6	6	...		51	0	45	8	4	12	0	12	Burn; 14 hours.
7	11	36	0	44	6	38	8	5	0	0	14	Cholera.
8	13	46	12	37	8	32	8	4	4	0	12	Fever.
9	19	...		45	0	39	0	5	0	1	0	Cholera.
10	19	...		44	4	37	8	5	8	1	4	Cholera and Malformation of heart.
11	19	74	0	42	5	37	6	4	$3\frac{1}{4}$	0	$11\frac{3}{4}$	Phthisis.
12	19	...		46	12	41	0	5	0	0	12	Fever.
13	20	...		49	0	43	0	5	0	1	0	Fever.
14	22	...		44	6	39	0	4	6	1	0	Fever.
15	30	...		46	0	40	0	5	0	1	0	Cholera.
16	36	104	8	43	0	37	8	4	8	1	0	Delirium tremens.
17	41	112	0	39	$1\frac{1}{2}$	33	$10\frac{1}{4}$	4	$11\frac{1}{4}$	0	12	Phthisis laryngea.
18	42	119	0	42	10	36	15	4	12	0	15	Carcinoma of liver, lungs, &c.
19	56	120	0	47	12	41	15	4	13	1	0	Cancer of breast.
20	56	115	0	48	4	42	2	5	3	0	15	Diseased heart.
21	76	...		44	6	38	6	5	0	1	0	Strangulated hernia and diseased heart.

Weight of Diseased Brains.

MALES.

	11	38	0	56	4	50	0	5	4	1	0	Chorea; 6 weeks.
	12	...		53	0	...		...		...		Convulsions.
	23	78	0	41	$3\frac{3}{4}$	35	1	5	3	0	$13\frac{3}{4}$	Phthisis, meningitis—malformation of heart.
	27	116	12	46	$5\frac{1}{2}$	40	0	5	6	0	$15\frac{1}{2}$	Acute meningitis.
	33	...		54	0	...		...		...		Apoplexy; 3 days, morbus cordis.
	62	...		39	12	35	0	4	4	0	8	Softening — morbus cordis et Renum.

FEMALES.

	$1\frac{3}{4}$ yrs.	13	8	31	0	27	0	3	8	0	8	Hydrocephalus.
	24	...		42	8	37	0		5	8		Oto-Meningitis.
	70	...		43	0	...		...		...		Apoplexy & diseased heart.

TABLE II.

Weight and Specific Gravity of Healthy Brain, &c., with Cause of Death, in Males and Females.

MALES.

No	Age.	Cause of Death.	Height.		Weight of Body.		Weight in Air. Avoird.		Specific Gravity.
			ft.	in.	lbs.		oz.	dr.	
1	21	Morbus Renum and Dropsy	5	10	...	Cerebrum	43	4	1,0362
						Cerebellum	5	7½	1,04219
						Pons Varolii and Medulla Oblongata	0	15¾	1,0351
						Encephalon	49	11¼	1,0364
2	26	Ulceration of Intestines	5	10	105	Cerebrum	41	14	1,0381
						Cerebellum	5	10	1,0448
						Pons Varolii and Medulla Oblongata	0	13	1,0461
						Encephalon	48	5	1,0392
3	28	Morbus Renum; Phthisis	5	7	104	Cerebrum	43	7½	1,03089
						Cerebellum	5	6½	1,0403
						Pons Varolii and Medulla Oblongata	0	13¼	1,0389
						Encephalon	49	11½	1,03211
4	33	Phthisis	...		...	Cerebrum	40	13	1,03718
						Cerebellum	5	7	1,04382
						Pons Varolii and Medulla Oblongata	0	12¾	1,03821
						Encephalon	47	0¾	1,03754
5	35	Diseased Hip	5	6	78	Cerebrum	41	10¼	1,0374
						Cerebellum	5	7¾	1,0418
						Pons Varolii and Medulla Oblongata	1	1¼	1.0428
						Encephalon	48	3¼	1,0383
6	35	Phthisis	5	5	63	Cerebrum	37	3½	1,0341
						Cerebellum	4	10½	1,0382
						Pons Varolii and Medulla Oblongata	0	14	1,0392
						Encephalon	42	12	1,0347
7	37	Abscesses & Secondary Deposits in Lungs, &c.	5	7	90	Cerebrum	38	12	1,0343
						Cerebellum	4	12	1,0419
						Pons Varolii and Medulla Oblongata	0	13	1,0400
						Encephalon	43	9¾	1,0352
8	44	Phthisis	5	8	91	Cerebrum	36	2	1,0357
						Cerebellum	5	7¼	1,0369
						Pons Varolii and Medulla Oblongata	0	13	1,0366
						Encephalon	42	6½	1,0357
9	59	...	5	6	100	Cerebrum	34	7½	1,03031
						Cerebellum	4	6	1,0447
						Pons Varolii and Medulla Oblongata	0	12	1,0434
						Encephalon	39	9½	1,0350

TABLE II.—*Continued.*

Specific Gravity of Healthy Brain in Females.

No.	Age.	Cause of Death.	Height.		Weight of Body.		Weight in air. Avoird.		Specific Gravity.
			ft.	in.	lbs.		oz.	dr.	
1	8	Burn; four days......	4	0	56	Cerebrum	42	5¼	1,0393
						Cerebellum	4	12	1,0482
						Pons Varolii and Medulla Oblongata	0	12¼	1,04714
						Encephalon	47	13½	1,0403
2	8	Abscess of Liver, and diseased Mesenteric glands	3	7	...	Encephalon	39	6	1,0368
3	23	Anasarca	5	7	...	Encephalon	46	0	1,03734
4	24	Fungoid disease of Liver & intestines	5	4	86	Cerebrum	40	7¾	1,0355
						Cerebellum	5	6¾	1,0411
						Pons Varolii and Medulla Oblongata	0	15	1,0368
						Encephalon	46	13½	1,0362
5	25	Morbus Renum	5	5	99	Cerebrum	35	12	1,0349
						Cerebellum	4	7	1,03807
						Pons Varolii and Medulla Oblongata	0	12	1,0445
						Encephalon	40	15	1,0354
6	66	Phthisis.................	5	4	70	Cerebrum	37	6¾	1,0351
						Cerebellum	4	15	1,0394
						Pons Varolii and Medulla Oblongata	0	12¾	1,0405
						Encephalon	43	2½	1,0357

Weight and Specific Gravity of Diseased Brain in Males and Females.

MALES.

No.	Age.	Cause of Death.	Height.		Weight of Body.		Weight in air. Avoird.		Specific Gravity.
1	11	Congenital Idiocy...	...		21½	Cerebrum	17	2¼	...
						Cerebellum, and Pons Varolii and Medulla Oblongata	4	1¼	...
						Encephalon	22	3½	1,030
2	11	Fractured Skull and Injury of Brain	4	2	42	Cerebrum	37	7¼	1,03907
						Cerebellum	4	13	1,043006
						Pons Varolii and Medulla Oblongata	0	11	1,0469
						Encephalon	42	15¼	1,0399
3	27	Acute Inflammation of Membranes of Brain	5	7	116	Cerebrum	40	0	1,03225
						Cerebellum	5	6	1,04242
						Pons Varolii and Medulla Oblongata	0	15½	1,03333
						Encephalon	46	5½	1,0332

FEMALES.

No.	Age.	Cause of Death.	Height.		Weight of Body.		Weight in air. Avoird.		Specific Gravity.
1	16	Miliary tubercle, Softening of Brain, and effusion	5	2	70	Cerebrum	43	11	1,0406
						Cerebellum	4	10¾	1,0420
						Pons Varolii and Medulla Oblongata	0	13¾	1,0371
						Encephalon	49	3½	1,0407

TABLE III.

Showing the heaviest, lightest, and mean weights of the Encephalon, and of its several portions, in the above observations, in the two sexes, and at different ages.

MALES.

Ages.	Numbers Weighed.				Heaviest.								Lightest.								Mean.							
	Encephalon.	Cerebrum.	Cerebellum.	Pons & Medulla.	Encephalon.		Cerebrum.		Cerebellum.		Pons and Medulla.		Encephalon.		Cerebrum.		Cerebellum.		Pons and Medulla.		Encephalon.		Cerebrum.		Cerebellum.		Pons and Medulla.	
					oz.	dr.	oz.	dr.	oz.	dr.	oz.	dr.	oz.	dr.	oz.	dr.	oz.	dr.	oz.	dr.	oz.	dr.	oz.	dr.	oz.	dr.	oz.	dr.
2 to 4 incl.	5	4	4	4	50	10	45	8	4	8	0	10	37	0	33	3	4	2	0	9	43	3·6	39	14·7	4	5·5	0	10·7
5 to 10	2	2	2	2	47	12	42	0	5	0	0	12	45	12	40	0	5	0	0	12	46	12	41	0	5	0	0	12
10 to 20	7	7	6	6	50	8	44	0	5	8	1	0	37	0	32	4	4	0	0	10	45	3·7	39	8·5	4	14	0	13·6
20 to 30	11	10	10	10	59	8	53	0	5	10	1	1	46	1	40	4	4	12½	0	12	50	4	43	14·9	5	4·3	0	14·7
30 to 50	13	11	11	11	56	4	50	0	6	4	1	2	42	6½	36	2	4	10	0	12	47	14	41	12·5	5	3·7	0	14·6
50 to 78	7	7	7	7	51	0	45	0	5	6	1	0	39	9½	34	7½	4	6	0	12	45	9·5	39	13·5	4	13·8	0	14·1
	45	41	40	40																								
From 20 to 50 yrs.	24	21	20	20	59	8	53	0	6	4	1	2	42	6½	36	2	4	10	0	12	48	15·4	42	13·9	5	4·5	0	14·7
FEMALES.																												
7 days,	1	1	1	1																	14	1	12	13	1	0·25	0	3·75
1 year,	1	1	1	1																	31	8	27	0	4	0	0	8
3 to 5 incl.	3	3	3	3	41	8	36	8	4	8	0	12	34	10	30	8	3	11	0	7	38	9·3	33	13·3	4	2·3	0	9·6
5 to 10	3	2	2	2	51	0	45	8	4	12	0	12¼	39	6	42	5¼	4	12	0	12¼	46	1·1	43	14·6	4	12	0	12·1
11 to 13	2	2	2	2	44	6	38	8	5	0	0	14	37	8	32	8	4	4	0	12	40	15	35	8	4	10	0	13
15 to 20	5	5	5	5	49	0	43	0	5	8	1	4	42	5	37	6	4	3¼	0	11¾	45	7·4	39	9·2	4	15	0	15·15
20 to 30	5	4	4	4	46	3½	40	7¾	5	6¾	1	0	40	15	35	12	4	6	0	12	44	11·3	38	12·9	4	12·9	0	14·7
30 to 50	3	3	3	3	43	0	37	8	4	12	1	0	39	1½	33	10¼	4	8	0	12	41	9·1	36	0·41	4	11·08	0	14·3
50 to 76	4	4	4	4	48	4	42	2	5	3	1	0	43	2½	37	6¾	4	13	0	12¾	45	14·1	39	15·4	4	15·7	0	14·9
	27	25	25	25																								
From 20 to 50 yrs.	8	7	7	7	46	13½	40	7¾	5	6¾	1	0	39	1½	33	10½	4	6	0	12	43	9·7	37	9	4	11·8	0	14

TABLE IV.

Showing the proportion of the Encephalon to the body, and of the Cerebellum to the Encephalon, in the two sexes, and at different ages, in all the observations.

MALES.			FEMALES.		
Ages.	Encephalon to Body.	Cerebellum to Encephalon.	Ages.	Encephalon to Body.	Cerebellum to Encephalon.
Years.					
2	1 to 8·8	1 to 9·6	7 days	1 to 7·9	1 to 14·07
2½	1 to 10·6	1 to 11·04	1 yr.	1 to 7·6	1 to 7·8
3	1 to 10·6	1 to 9·2	3 yrs.	1 to 7·7	1 to 8·8
5	1 to 7·3	1 to 9·15	3 ,,	1 to 8·8	1 to 9·3
10	1 to 15·08	1 to 9·5	5 ,,	1 to 10·7	1 to 9·7
15	1 to 27·8	1 to 9·1	8 ,,	1 to 18·3	1 to 10·06
21	1 to 37·9	1 to 10·2	11 ,,	1 to 12·8	1 to 8·8
21	1 to 37·3	—	13 ,,	1 to 19·6	1 to 8·5
23	1 to 30·3	1 to 7·9	16 ,,	1 to 22·7	1 to 10·6
24	1 to 31·9	1 to 9·9	19 ,,	1 to 27·9	1 to 10·1
26	1 to 33·4	1 to 9·2	24 ,,	1 to 29·3	1 to 8·7
28	1 to 34·7	1 to 8·5	25 ,,	1 to 37·9	1 to 9·2
35	1 to 25·8	1 to 8·8	36 ,,	1 to 38·6	1 to 9·5
35	1 to 23 5	1 to 9·2	41 ,,	1 to 45·8	1 to 8·3
37	1 to 32·3	1 to 9·8	42 ,,	1 to 44·6	1 to 8·9
37	1 to 33·05	1 to 9·17	56 .,	1 to 40·02	1 to 9·9
40	1 to 36·08	—	56 ,,	1 to 38·1	1 to 9·3
44	1 to 34·6	1 to 7·7	66 ,,	1 to 25·9	1 to 8·7
55	1 to 29·2	1 to 8·6	— ,,	—	—
59	1 to 44·4	1 to 9·04	— ,,	—	—
From 21 to 44 incl. Mean of 12 obs., extremes.	1 to 32·73, 1 to 23·5, and 1 to 37·9	(10 observ.) 1 to 9·03 1 to 7·7 and 1 to 10·2	From 24 to 42 incl. Mean of 5 obs. extremes.	1 to 39·2, 1 to 29·3, and 1 to 45·8	1 to 8·9 1 to 8·3 1 to 9·5

TABLE V.

Showing the highest, lowest and mean specific gravity of the Encephalon, and its several portions, in adults.

MALES.

	Number of Observations.	Ages.	Highest.	Lowest.	Mean.
Cerebrum	9	21 to 59	1·0381	1·03031	1·03488
Cerebellum	9		1·0448	1·0369	1·04162
Pons Varolii and Medulla Oblongata	9		1·0461	1·0351	1·04006
Encephalon	9		1·0392	1·03211	1·03623
FEMALES.					
Cerebrum	3	23 to 66	1·0355	1.0349	1·0351
Cerebellum	3		1·0411	1·03807	1·03952
Pons Varolii and Medulla Oblongata................	3		1·0445	1·0368	1·0406
Encephalon................	4		1·03734	1·0354	1·03616

The general results to be deduced from the above observations and tables are :—

1. The weight of the brain in the adult male averages about forty-nine ounces avoird., and ranges from about forty-two to nearly sixty ounces.

In the adult female the weight of the brain averages about forty-three ounces and a-half, and ranges from thirty-nine to nearly forty-seven ounces. The mean difference is thus about five ounces and a-quarter.

In the previous series of observations,[*] which greatly exceeded in number that now published, the male encephalon had an average of about fifty ounces; the female of nearly forty-five ounces, or a difference of nearly five ounces and a-quarter, and the range was in both sexes more extensive.

The average weight of the encephalon in these calculations corresponds, therefore, sufficiently with the previous results, as well as with those obtained by Dr. Reid, and does not differ greatly from the conclusions of Sir W. Hamilton, Dr. Sims, and Dr. Clendinning. The average weight of the brain, as deduced by these observers, ranges from forty-five ounces and three-quarters to fifty ounces and a-quarter in males, and from forty-one ounces and a-quarter to forty-five ounces in females. The observations of Portal, Tiedemann, M. Lelut, and M. Parchappe are also similar.

2. The encephalon increases in weight up to adult age, and again declines in advanced life. This fact is, from their comparatively small number, less satisfactorily illustrated by the observations now published than by the previous series and by the observations of Dr. Reid and Dr. Boyd.[†] In a table published in 1851,[‡] embracing the whole of Dr. Reid's observations and my own up to that date, it is very clearly shown, that, though the brain of young persons is occasionally found to be very heavy, it does not usually obtain its full development till between twenty and thirty years of age, and undergoes a decided decline in weight in advanced life.

3. The proportion which the whole encephalon bears to the body varies greatly according to the state of obesity or emaciation of the subject, but it generally decreases with the advance of life. In the adult male, aged from twenty-one to forty-four inclusive, the mean proportion was as 1 to 32·73, and the range from 1 to 23·5 to 1 to 37·9. In the adult female from twenty-four to forty-two years of age, the mean was 1 to 39·2, and the range 1 to 29·3, and 1 to 45·8.

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[*] See Paper in "Edinburgh Monthly Journal," Vol. VII., 1847.

[†] "Wagner's Physiology," by Willis, 1844, Appendix, p. 700.

[‡] "London Journal of Medicine," Vol. I.

4. The cerebellum bears much the same relation to the whole encephalon throughout the duration of life, at least after very early age. In the adult male it averaged 1 to 9·03, and ranged from 1 to 7·7 to 1 to 10·2. In the adult female it averaged 1 to 8·9, and ranged from 1 to 8·3 to 1 to 9·5.

5. The specific gravity of the brain in the adult is similar in the two sexes (1·036 in both the male and female); nor is there any very material difference in the density of the several portions of the encephalon; the specific gravity of the cerbellum and of the pons Varolii and medulla oblongata being, however, in both sexes, greater than that of the cerebrum. The observations do not afford satisfactory information as to the influence of age on the specific gravity of the brain.

6. The observations in the weight and specific gravity of the diseased brain are too few to warrant any conclusions being deduced from them; but there can be no doubt, that the brains of persons who die of inflammatory diseases of that organ, or of diseases which interfere with the free transmission of the blood through the lungs and occasion general venous congestion, are usually heavier than those of persons who die of other affections. Dr. Peacock, *7th of May*, 1861.

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